

BLM LIBRARY



88036602

Bureau of Land Management Global Change Research Program



**U.S. Department of the Interior
Bureau of Land Management**

QC
981.8
.C5
B977
1993
c.2

Table of Contents

BLM LIBRARY
SC-653, BLDG. 50
DENVER FEDERAL CENTER
P. O. BOX 25047
DENVER, CO 80225-0047

Introduction	1
Chihuahuan Desert	2
Global Change and the Chihuahuan Desert of Southern New Mexico	
San Pedro River Watershed	4
Effects of Past and Contemporary Climate on the Hydrologic Regimes and Ecological Communities of the San Pedro River Watershed Upstream of Winkelman, Arizona	
Snake River Birds of Prey Area	6
Relationship Between Weather, Fire pattern, and Vegetation Change in the Snake River Birds of Prey Area, Idaho	
Vegetation Diversity	8
Research and Demonstration to Restore and Maintain Native Plant Diversity on Deteriorated Rangelands in the Great Basin and Columbia Plateau	
Wilderness Area / Paired Ecosystems	10
Intermountain Wilderness Area Ecosystem Study (IWAES) Impact of Global Environmental Change Using Paired Ecosystems in North America and the USSR	
Global Change Data Center	12
Coordination and Data Management Assistance for the Development and Operation of a Global Change Data Center	

CREDITS

Text: Laura Huenneke; Mitchell McClaran; Steven Knick; Michael Borman; Mike Sestak; Jim Sulzman; Elizabeth Whippo Cline

Photographs: Laura Huenneke, David Lightfoot; Diane Drobka, Mitchell McClaran, Mike McQueen; Janelle Corn, Steven Knick, Peter Sharpe,
Beatrice Van Horne; Jerry Asher, David Pyke; Al Riebau

Technical Editing: Elizabeth Whippo Cline; Carol L. Simmons; Jeanne Hammond; BLM Wyoming State Office—External Affairs,
Printing and Electronic Publishing Section, and Technographics

Cover Design: Colorado State University, Public Relations Department

Coordination: Elizabeth Whippo Cline

The BLM Global Change Research Program is part of the U.S. Global Change Research Program (USGCRP). The USGCRP is a Presidential Initiative developed by the Committee on Earth and Environmental Sciences, of the Federal Coordinating Committee for Science Engineering and Technology, Office of Science and Technology Policy.



Can past climate patterns be used to predict future climate changes? How will native grass communities react to changes in precipitation patterns in the Great Basin of the United States — will native grasses be replaced by other, perhaps less desirable, species? Can we compare relatively pristine ecosystems across the world to similar ecosystems in the United States to detect global-scale changes? How will grazing and climate changes interact to affect ecosystems in the Chihuahuan Desert? Can we accurately relate ground-based vegetation measurements to satellite images?

Answers to these and other questions will prepare land managers, policy-makers and the public to meet the challenges of global-scale environmental changes. As the steward of over 270 million acres of public land in the United States (primarily in the West and Alaska), the Bureau of Land Management (BLM) is preparing to meet these challenges through its participation in the U.S. Global Change Research Program (USGCRP). The Nation's largest federal land manager, the BLM is committed to maintaining ecosystem stability and biodiversity while fulfilling its multiple-use mandate.

The basic goals of the BLM Global Change Research Program (BLM GCRP) are to:

- determine the sensitivity and response of ecosystems and ecological processes to existing climate conditions and other environmental factors and human influences on local and regional scales;
- evaluate how future global change may influence ecosystem structure and function, and how such influences may affect long-term viability and productivity of rangelands, forestlands, wetlands, riparian areas, tundra and other sensitive ecosystems on the public lands; and
- assess implications for future natural resource management on the public lands to sustain multiple uses, productivity, health and diversity.

The projects of the BLM Global Change Research Program are diverse; they range from investigating past climates using tree-ring data to monitoring ecological and environmental conditions at 15 sites in the western United States. The ecosystems being studied cover large regions and reflect the wide range of ecological and physical environmental conditions typical of public lands and natural resources managed by the BLM. Information from these projects will help the Bureau anticipate changes to the ecosystems and will provide other global change researchers with quality data. The six projects are (see map, back inside cover):

- Global Change and the Chihuahuan Desert of Southern New Mexico.
- Effects of Past and Contemporary Climate on the Hydrologic Regimes and Ecological Communities of the San Pedro River Watershed Upstream of Winkelman, Arizona.
- Relationship Between Weather, Fire Pattern, and Vegetation Change in the Snake River Birds of Prey Area, Idaho.
- Vegetation Diversity — Research and Demonstration to Restore and Maintain Native Plant Diversity on Deteriorated Rangelands in the Great Basin and Columbia Plateau.
- Intermountain Wilderness Area Ecosystem Study (IWAES).
- Impact of Global Environmental Change Using Paired Ecosystems in North America and the USSR.

Data and information from all BLM global change research projects are managed at the BLM Global Change Data Center (GCDC). After the agreed upon time of proprietary use by the project researchers, data are distributed by the GCDC to BLM personnel and other researchers who request them.

Chihuahuan Desert

Over the past century, large expanses of semi-arid grassland in southern New Mexico and western Texas have been invaded by Chihuahuan desert shrubs, such as creosote bush and mesquite. Today the northern Chihuahuan desert supports a complex mix of grasses, shrubs, cactus and yucca - each having unique responses to grazing and climate. Future shifts in climate are likely to change the balance among plant species; vegetation changes, in turn, will alter the resource base for grazing and other uses of regional public lands. BLM-supported studies of global change in New Mexico focus on the reproductive biology of dominant plants of the northern Chihuahuan desert. Seed production, seedling establishment, clonal spread, and responses to grazing by livestock and native animals are being studied. This biological information will form the basis for predicting vegetation response to climate change.

Scientists based in the Department of Biology at New Mexico State University (NMSU) are studying desert rangelands of southern New Mexico. Research sites near Las Cruces include land administered by the Jornada Experimental Range of the USDA's Agricultural Research Service, the NMSU College of Agriculture, the BLM, the U.S. Fish and Wildlife Service, and U.S. Army White Sands Missile Range. Field studies are coordinated with those of the Jornada and the Sevilleta Long-Term Ecological Research (LTER) programs, supported by the National Science Foundation.



One study focuses on the growth, reproduction and seed germination of creosote bush, a major invader. The rapid spread of creosote bush over large areas is hard to explain given its basic nature as a slow growing desert shrub. The characteristic dunes formed by invading mesquite are also being studied. Historical information is used to correlate the extent, physical development and spread of dunes with past climate conditions.

Another project is investigating the conditions that promote the invasion of grassland by shrubs. Experimental manipulations are being used to study growth and reproduction of grasses, the response of grasses to clipping and to drought, and the fates of shrub seeds and seedlings in grasslands with different histories and current conditions.





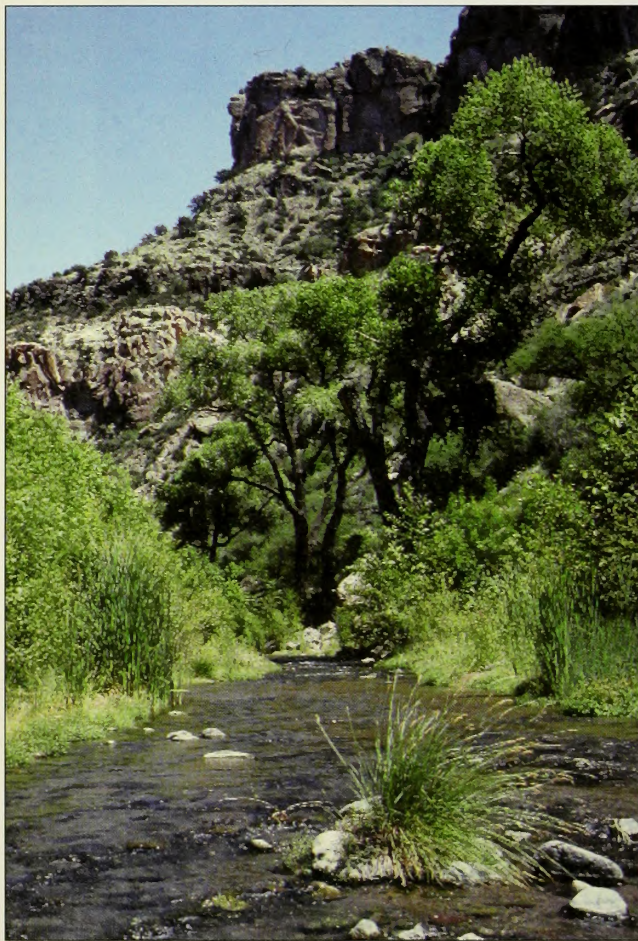
To investigate effects of livestock grazing on the resilience of rangelands to climatic change, plant and animal populations are being monitored on opposite sides of fencelines at five sites in south-

central New Mexico. At each site, livestock grazing on one side of the fenceline has been light to moderate for the region for at least 15 years; on the other side of the fenceline, there have been no domestic grazers for that same length of time. Long-term patterns in plant and grasshopper species composition and diversity, and the stability of plant, grasshopper, and rabbit populations are being measured. Results should improve understanding of how livestock grazing influences the way plants and native herbivores respond to climate change.

These population-level studies will provide information from which to predict the overall change in vegetation structure to be expected as land use and climatic patterns change in the region.

San Pedro River Watershed

The dramatic elevation changes and semi-arid climate of the San Pedro watershed of southern Arizona and northern Mexico provide the habitat for a great assortment of plant and animal species. In this 700 square-mile watershed, saguaro cactus and desert tortoise live in hot desert settings below 3000 feet, and Engelmann spruce and brown bear inhabit cool subalpine environs above 9000 feet. Between these elevation and climatic extremes are semi-desert grasslands, oak woodlands, ponderosa pine forests, and several types of riparian communities.



The extraordinary variety of species and landforms in the San Pedro watershed provide a living laboratory in which scientists are evaluating the potential effects of global change on plants and animals. Scientists from the University of Arizona's School of Renewable Natural Resources, Tree Ring Laboratory, and Office of Arid Land Studies are taking an interdisciplinary approach to this research. Work began with an extensive review of existing information about the area and possible effects of global change on its plants and animals. Current efforts are aimed at gathering new information to enhance understanding of historic and contemporary relationships between climate and species.

Scientists at the School of Renewable Natural Resources are identifying plant and animal species that appear to be sensitive to changing climate. They suggest that different species will respond in different ways to changing climates, and that species growing as neighbors today may not coexist under the climate of tomorrow.

At the Tree Ring Laboratory, researchers are describing the geologic history of the San Pedro River floodplain and the climate history of the area

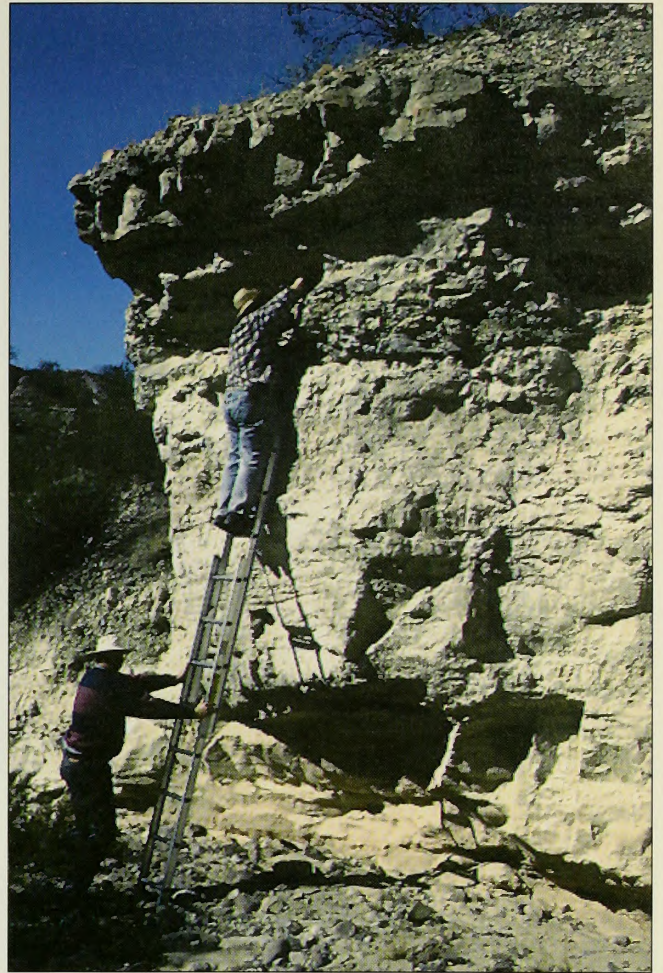
during the last 18,000 years. Periods of dramatic erosion and down-cutting as well as periods of deposition and terrace building appear to be associated with past climates that differ in both annual and seasonal temperature and precipitation patterns.



A Geographic Information System (GIS) database of vegetation, topography, temperature, precipitation, and soils for the watershed is being developed at the School of Renewable Natural Resources and the Office of Arid Land Studies. The GIS database integrates information from all aspects of this project.

Historic relationships between climate and plant species over the last 1000 years are being assessed by comparing the climate record found in tree rings with species changes indicated through the fossil plant remains in packrat middens and soil. Low-level airborne video and the GIS database are being used to assess contemporary distribution and abundance patterns in individual plant species described by scientists in relation to topography, soils and climate.

Historic and contemporary studies will be integrated to evaluate potential effects of global change on plants and animals. This integration will involve the use of computer models to predict changes in the distribution and abundance of individual species under different climate changes.



This individual species approach emphasizes the unique response of species to climate and may predict species associations that are quite different from those we see today.

Snake River Birds of Prey Area

The Snake River Birds of Prey Area, in southwestern Idaho, encompasses more than 600,000 acres of shrub-steppe vegetation within the Great Basin region of the western United States. Models of global climate change predict significant changes in precipitation for mid-latitude regions such as the Great Basin. Such changes in precipitation are likely to lead to changes in vegetation structure and composition. To document current baseline conditions and study long-term change, the BLM's Raptor Research and Technical Assistance Center (RRTAC) is using satellite technology to map and describe vegetation in the Snake River Birds of Prey Area.

Vegetation maps created from satellite images have the advantage of providing fine-scale resolution over a large area. In addition to documenting current conditions, the detailed vegetation map of



the Snake River Birds of Prey Area is providing critical information for other RRTAC research. Because vegetation in deserts is sparsely distributed, the satellite "sees" mostly bare ground, rather than vegetation. As a result, vegetation maps of deserts, such as the Snake River Birds of Prey Area, are more difficult to create than maps of forested regions.



The Global Climate Change Program at RRTAC is developing the technology needed to translate satellite images of sparsely vegetated areas into vegetation maps. For example, scientists are using the map to study the influence of land-use practices and wildfire on the distribution and abundance of vegetation, raptors, and their prey. In another study, ecologists are examining the relationship between habitat fragmentation and the diversity of bird communities. The vegetation map characterizes landscapes with sufficient detail to enable these scientists to draw conclusions about relationships between habitats and the diversity of animal life. By understanding these relationships,





land managers can make better management decisions and plan more effectively for future conditions under various predictions of global climate change.

Producing a vegetation map from a satellite image involves iterative applications of field sampling information and computer processing techniques. Field crews use a Global Positioning System, a tool of the satellite age, to record the exact location of a habitat type at an accuracy of five meters or better. Using a computer GIS program, a geographer maps each sample location and habitat type on the precise pixel, or dot, in the satellite image that represents that 25-meter square on the ground. Researchers then develop a statistical description of the spectral reflectance of each habitat type in the satellite image. This information is used to classify other pixels in the image which have not been visited on the ground. The final vegetation map is created when all pixels in the image have been assigned a habitat type.

Using the methods developed in this project, researchers will create vegetation maps from



satellite images at regular intervals to compare with the initial baseline map. This will enable them to determine rates of change in the landscape and identify regions of greatest change. By understanding the ways that habitats respond to long-term changes in global climate and other factors, land managers can anticipate changes and take action to sustain the productivity and biodiversity of ecosystems.

Vegetation Diversity

The Vegetation Diversity Project (VDP) was initiated by the BLM as a multi-state project to restore and maintain diverse native plant communities in the northern Great Basin and Columbia/Snake River Plateau regions. The VDP is a project of the BLM Cooperative Research Unit at Oregon State University (OSU). The research is being conducted by BLM rangeland ecologists and OSU scientists.

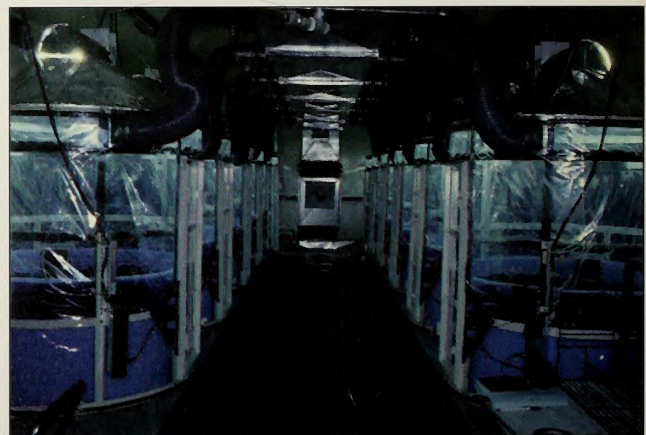


Potential impacts on vegetation from increased carbon dioxide (CO₂) levels and predicted global climate changes prompted the VDP and the Department of Rangeland Resources, OSU, to initiate research on: 1) effects of increased CO₂ and changes in precipitation patterns on plants and soil systems, 2) demography of exotic and desirable plant species, and 3) long-term monitoring of vegetation diversity.

Plant succession, growth and survival, and several soil parameters which influence plant growth (temperature, moisture, mycorrhizal activity, and carbon, nitrogen and sulfur levels) are being studied to determine their response to increased CO₂ and shifts in the seasonal distribution of precipitation. Evaluations are being made under



three scenarios of precipitation distribution: 1) a relatively wet winter and spring followed by a dry summer (representing the normal pattern in the northern Great Basin), 2) a dry winter, with a wet spring and summer (representing a precipitation shift to spring and summer), and 3) a wet winter, with a dry spring and summer (representing a precipitation shift to a primarily winter regime). Field experiments are being conducted under rainout shelters, with supplemental irrigation, at the Squaw Butte Experimental Range in southeastern Oregon. Additional studies are being performed in growth chambers designed to regulate air and soil temperatures and CO₂ levels.



Another VDP study compares seedling growth of selected weed and desirable perennial plant species in environmental chambers under different simulated spring growth conditions. Researchers are evaluating seedling growth under cool-dry, cool-wet, warm-dry and warm-wet conditions. Field evaluations of competition among a variety of desirable perennial species and exotic annual invaders will complement this study. Theory suggests that many annual invaders may benefit from global climate change. In other field studies the VDP is quantifying vegetation diversity on near-pristine and degraded rangelands within the Great Basin and Columbia-Snake River Plateau regions under current climatic conditions. Long-term demographic studies of exotic and desirable plant species will complement these studies by contributing to an understanding of how species respond to each other, and to seasonal and climatic changes.



These studies, individually and together, will help identify potential changes in soils, vegetation and biodiversity in the intermountain sagebrush-steppe as functions of changes in CO₂ levels and temperature, and seasonal shifts in precipitation.



Wilderness Area Ecosystems/ Paired Ecosystems

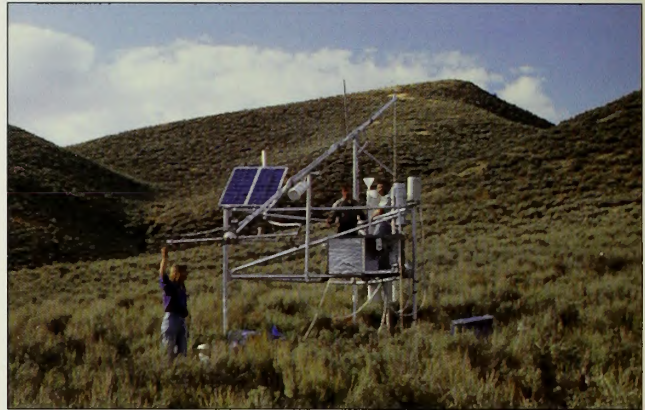
Our physical, chemical and biological environment is constantly changing. Because of this natural variability, it is difficult to determine whether a change in a single environmental factor at a specific location indicates a more widespread, directional change. To detect global-scale changes more easily, scientists and staff at the Environmental Science and Technology Center (ESTC) are engaged in two global change research projects measuring a range of environmental factors in a network of sites across the western United States and beyond. The ESTC is a cooperative research unit between the Wyoming State Office of the BLM and the Earth Resources Department at Colorado State University.

Wilderness Area Ecosystems: Fifteen sites in the western U.S. were chosen to represent a wide variety of ecosystem types with little chance of local human impact. Most sites are located adjacent to or within BLM Wilderness Areas or Wilderness Study Areas. Environmental measurements of four types are made at each site - air quality, water quality, aquatic biology and vegetation. Satellite remote sensing and GIS are used to provide landscape-scale characterization of current conditions.



A low impact, battery/solar-powered station was designed at the ESTC to operate dependably in these remote areas and extreme conditions. A

station is placed at each site to measure climate and air quality. Wind, temperature, humidity, rainfall, total solar and UV-B radiation are measured hourly. In addition to hourly climate data, air pollutant concentration and rain/snowfall chemistry samples are collected monthly.



Measurements of surface water quality and aquatic biology are made at each site in the spring, summer and fall of each year. The qualities measured include chemical characteristics, such as acidity and ion concentrations; biological attributes, such as the number and variety of aquatic insects; and physical parameters, such as the rate of flow and temperature of the water.

Vegetation measurements, including species composition, plant biomass, cover, and stage of plant maturation (phenology), are made annually at each site to describe species diversity and ecosystem structure. These measurements are made along transects in three different types of locations: relatively dry, moderate, and areas containing specific indicator species to determine how responses vary.

Analyses of the climate and ecological measurements are aimed at 1) determining whether trends exist, and 2) assessing relationships between meteorological or air quality parameters and ecological measurements.



Paired Ecosystems: Similar changes in climate and ecological factors at sites located oceans apart would be a dramatic demonstration of global change. Ecosystem transition zones, where plants and animals already exist at the boundaries of their distributions, may be the first areas to exhibit such changes. Thus, this project focuses on measuring the same environmental factors in ecological transition zones at paired sites in North America and states of the former Soviet Union.

The measurements chosen for the Paired Ecosystems study are based upon the IWAES project. Data collection techniques are the same as those used in the IWAES network. The selection of four pairs of sites was based on similarity of ecosystems, freedom from impact caused by nearby human activity, ease of accessibility, and jurisdictional responsibility. The site types include the desert-dry savanna/shrubland ecosystem boundary, the mid-latitude timberline-alpine ecosystem boundary, the polar front/mixed coniferous-deciduous forest ecosystem boundary, and continental high pressure (ozone depletion) sites.



Global Change Data Center

The BLM Global Change Data Center (BLM GCDC) was established to store, validate, and distribute data collected by BLM global change research program projects. It is located at the Natural Resource Ecology Laboratory at Colorado State University in Fort Collins, Colorado. The primary goal of the BLM GCDC is to provide data, and information about those data, to scientists and other individuals interested in global change.

The scientists with each research project send the data they have collected to the BLM GCDC. Data files are cataloged and checked for consistency before being added to the master database. The data are stored (archived and backed-up) preventing accidental loss.

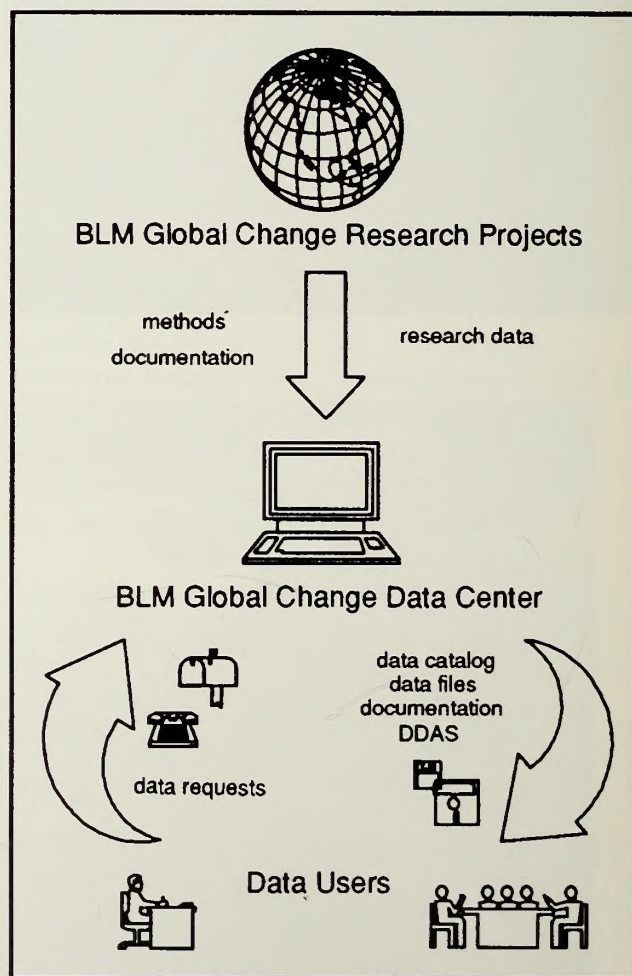
Along with the data, information about who conducted the research, where the research was done, what was studied, and what methods were used to collect data is stored at the BLM GCDC. This documentation will allow other scientists to reproduce the studies and compare the outcomes. The BLM GCDC also has documentation of the database structure (contents and formats), data processing programs and data management procedures.

An up-to-date catalog of the information available at the BLM GCDC is maintained so that people interested in the data can choose data files that interest them, contact the Data Center, and have data sent to them on computer diskettes. Documentation describing data files and research projects is also sent.

The data user may request that the BLM GCDC Distributed Data Access System (DDAS), which operates on an IBM-compatible personal computer, be sent with the data files. This system allows the scientist to view the data in each data file, extract and save specific columns of data, and construct simple graphs.

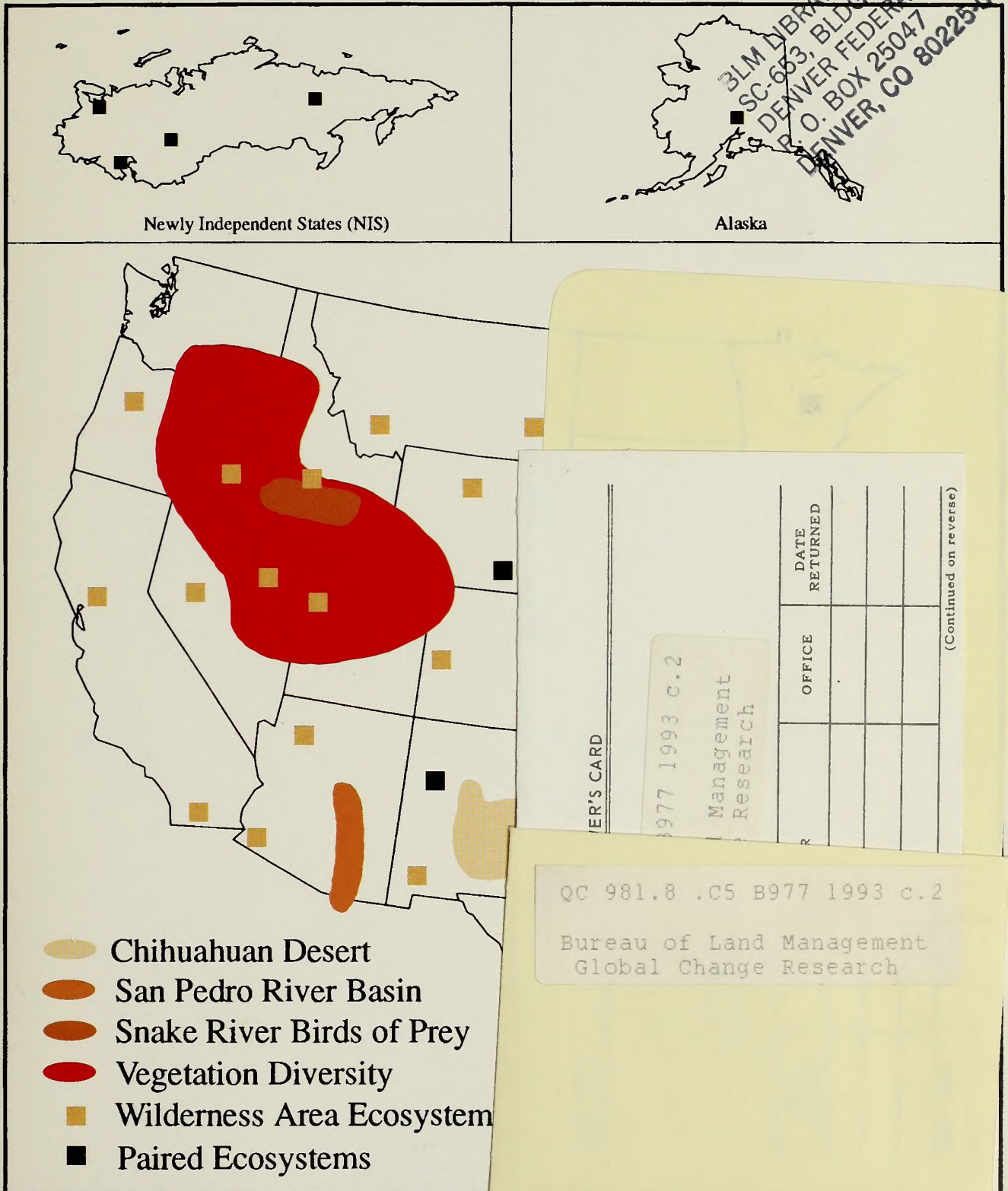
BLM GCDC personnel are also designing a system which will enable people from around the world to use a personal computer to gain access to data files over a computer network. This system will provide immediate access to all data files in the master database at the BLM GCDC.

The ready availability of these data to global change investigators will contribute to the goal of understanding global-scale changes, and how these changes may affect our natural resources and the earth system.



BLM Global Change Research Projects

BLM Global Change Research Projects



BLM Global Change Research Program Personnel

CHIHUAHUA DESERT

Barb Masinton, Project Leader
Bureau of Land Management
New Mexico State Office
PO Box 27115
Santa Fe, NM 87502-7115
(505) 438-7445

Dr. Laura F. Huenneke
Department of Biology
New Mexico State University
Las Cruces, NM 88003
(505) 646-3933

Dr. David C. Lightfoot
Department of Biology
University of New Mexico
Albuquerque, NM 87131
(505) 277-8949

Dr. Richard E. Miller
Department of Biology
New Mexico State University
Box 3001
Las Cruces, NM 88003
(505) 646-1728

Lisa Beres
Department of Biology
New Mexico State University
Las Cruces, NM 88003
(505) 646-1332

SAN PEDRO RIVER WATERSHED

Mike McQueen, Project Leader
Bureau of Land Management
Safford District Office
425 E. 4th Street
Safford, AZ 85546
(602) 428-4040

Dr. Mitchel P. McClaran
SRNR
325 Biological Sciences East
University of Arizona
Tucson, AZ 85721
(602) 621-1673

Dr. Guy McPherson
SRNR
325 Biological Sciences East
University of Arizona
Tucson, AZ 85721
(602) 621-5388

Dr. William Mannan
SRNR
325 Biological Sciences East
University of Arizona
Tucson, AZ 85721
(602) 621-7283

Dr. David M. Meko
Laboratory of Tree-Ring Research
University of Arizona
Tucson, AZ 85721
(602) 621-3457

Lisa J. Graumlich
Laboratory of Tree-Ring Research
University of Arizona
Tucson, AZ 85721
(602) 621-6465

Dr. Lee Graham
SRNR
University of Arizona
325 Biological Sciences East
Tucson, AZ 85721
(602) 621-7270

Dr. Stuart Marsh
Office of Arid Lands Studies
University of Arizona
Tucson, AZ 85721
(602) 621-7896

SNAKE RIVER BIRDS OF PREY

Dr. Steven T. Knick, Project Leader
Bureau of Land Management
Raptor Res. & Techn. Assist. Ctr.
3948 Development Avenue
Boise, ID 83705
(208) 384-3483

Dr. James C. Munger
Department of Biology
Boise State University
Boise, ID 83725
(208) 385-3560

Dr. John T. Rotenberry
Department of Biology
University of California
Riverside, CA 92521
(714) 787-3953

Thomas J. Zarriello
Bureau of Land Management
Raptor Res. & Techn. Assist. Ctr.
3984 Development Ave.
Boise, ID 83705
(208) 384-3479

William Kramber
Idaho Dept. Water Resources
Boise, ID 83706
(208) 327-7227

VEGETATION DIVERSITY

Dr. David A. Pyke, Project Leader
Bureau of Land Management
Pac. For. Basin Rangeland Systems
Coop. Res. Unit
3200 S.W. Jefferson Way
Corvallis, OR 97331
(503) 750-7307

Dr. Michael M. Borman
Bureau of Land Management
Pac. For. Basin Rangeland Systems
Coop. Res. Unit
3200 S.W. Jefferson Way
Corvallis, OR 97331
(503) 750-7338

WILDERNESS AREA ECOSYSTEMS

Allen R. Riebau, Project Leader
ESTC
2401 Research Blvd., Suite 205
Fort Collins, CO 80526
(303) 491-2335

Dr. Michael Sestak
ESTC
2401 Research Blvd., Suite 205
Fort Collins, CO 80526
(303) 221-4873

Doug Ouren
ESTC
2401 Research Blvd., Suite 205
Fort Collins, CO 80526
(303) 221-4871

Lucinda Smith
ESTC
2401 Research Blvd., Suite 205
Fort Collins, CO 80526
(303) 221-4871

PAIRED ECOSYSTEMS

Allen R. Riebau, Project Leader
ESTC
2401 Research Blvd., Suite 205
Fort Collins, CO 80526
(303) 491-2335

Dr. Freeman Smith
Department of Earth Resources
Colorado State University
Fort Collins, CO 80523
(303) 491-5678

GLOBAL CHANGE DATA CENTER

Carol L. Simmons, Coordinator
BLM Global Change Data Center
NREL
Colorado State University
Fort Collins, CO 80523
(303) 491-5580

Elizabeth Whippe Cline
BLM Global Change Data Center
NREL
Colorado State University
Fort Collins, CO 80523
(303) 491-5643

BLM GCRP COORDINATOR

Stanley G. Coloff
Global Change Coordinator
Bureau of Land Management
1849 C St., N.W.
Washington, DC 20240
(202) 653-9193